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Genetic Variability And Character Association For Morphological And Seed Yield Related Traits In Indian Mustard (*Brassica juncea (*L.) Czern and Coss) Germplasm Under Heat Stress Conditions

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Abstract :

Sixty four germplasm of Indian mustard [*Brassica juncea* (L.) Czern and Coss] were evaluated to estimate variability, heritability and genetic advance in yield and yield components at Department of Plant Breeding and Genetics, R.B.S. College, Bichpuri, Agra during *rabi,* 2014-2015. The experiment was conducted using a Randomized Complete Block Design withthree replications. Significant genotypic variability among the test genotypes was observed for all traits studied. Higher values of phenotypicco- efficients of variation and genotypic co-efficients of variation were observed seed yield per plant, secondary branches per plant, 1000 seed weight and siliquae per plant indicating the existence of higher magnitude of variability among the test genotypes for effective selection inrespect of the above characters. Higher heritability estimates values were recorded secondary branches per plant, 1000 seed weight, fiber content, oil content, days to maturity, seed yield per plant and number of seeds per siliqua, indicating these traits were less influenced by environmental factors and selection for them is fairly easy. Higher valuesof expected genetic advance as per cent of mean was recorded for secondary branches, seed yield per plant, 1000 seed weight, number of siliquae per plant, indicating that selection would be more useful toimprove these traits. High estimates of heritability coupled with high genetic advance were observed for secondary branches, seed yield per plant, 1000 seed weight. High heritability coupled with medium genetic advance for fiber content, days to maturity. Medium heritability with medium genetic advance was for siliquae per plant. Low heritability with low genetic advance was for plant height. Under path coefficient analysis, on partitioning of the correlation coefficients of different characters with seed yield per plant into direct and indirect effects, it was observed that siliquae on main shoot length, days to 50% flowering, seeds per siliqua, secondary branches per plant, siliqua length and oil content had positive direct effect on seed yield.

Key Words : Indian mustard, Heritability, Genetic advance, Genotypic variation, Phenotypic variation, Yield, Fibre content

Introduction

Indian mustard [B. juncea (L.)Czern and Coss] is one ofthe most important oil seed crops of the country and itoccupies considerably large acreage among the Brassica groupof oil seed crops. India stands first both in acreage andproduction of rapeseed and mustard in Asia. Rapeseed and mustard crops arebeing cultivated in 53 countries spreadingover six continents across the globe. India(14.8%) is having third largest share inrapeseed-mustard production in the worldnext only to China and Canada. Amongannual oilseeds, rapeseed and mustardcontributed about 23 per cent acreage andover 25 per cent production over the lastfive years in India. In India the area of Rape and Mustard 6.32 Mha, Production 7.92 MT and yield 1254 kg/ha in. (Anonymous 2016-17). In

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terms of area under oilseeds, India holds premier position in the world but the yield of the most of oilseeds is less than the world average. On the other hand the demand of edible oils is increasing very rapidly with increasing population and has been estimated to be 20.20 million tonne for year 2020, 28.40 million tonne for the year 2030 and 41.6 million tonne for the year 2050 (Arvind Kumar, 2017). In India, mustardand rape seed are being grown largely in states like, UttarPradesh, Rajasthan, Haryana, Assam, Gujarat, Punjab, WestBengal and Madhya Pradesh.Thesuccess of any breeding programme depends up on the genetic variability engraved in the breedingmaterial. The assessment of parameters includingphenotypic and genotypic coefficients of variation,heritability in broad sense, and genetic advance as% of mean is a pre-requisite for making effectiveselection. Yield is a complex trait, polygenic ininheritance, more prone to environmentalfluctuations than ancillary traits such as branches/plant, seeds/siliqua, main shoot length, and 1000-seedweight. Understanding the association between yieldand its components is of paramount importance formaking the best use of these relationships in selection (Sarawgi *et al.,* 1997). The pathcoefficient analysis helps breeders to explain directand indirect effects, and hence been extensively usedin breeding experiments in different crop species(Ali *et al*., 2003; Akbar *et al*., 2003). The presentinvestigation was undertaken to assess the geneticvariability, trait association, and path coefficientanalysis in Indian mustard.

Materials And Methods

The experimental material comprising of 64 germplasm of Indian mustard (*Brassica juncea* L. Czern & Coss.) were grownat the research area of the Oilseeds Section, Department of Plant Breeding and Genetics, R. B. S. College, Bichpuri, Agra during *rabi,* 2014-2015 in randomizedblock design with three replications. Each genotype were grown in 1 rows of 2.5 m length with row to row distance of 30 cm apart and plant to plant spaced at 10cm achieved by thining at 15-20 days after sowing. The observations were recorded onfive randomly selected plants for fifteen traits,including Days to 50% flowering, Days to maturity, Plant height (cm), Primary branches per plant,Secondary branches per plant, Main shoot length (cm), Siliqua on MSL, Siliqua per plant, Siliqua length (cm), Seeds per siliqua, Seed yield per plant (g), 1000- seed weight (g), Oil content(%) and Fiber content. Data collected for each trait were subjected to analysis of variance for Randomized Complete Block Design as suggested by Panse and Sukhatme (1957). To estimate the extent of variability, genotypic and phenotypic co-efficients of variability were estimated according to the method suggested by Burton (1952). The broad sense heritability and genetic advance as per cent of mean were calculated as proposed by Jonson *et al.* (1955). Phenotypic and genotypic correlation co-efficients for seed yield were calculated for each pair of traits as described by Singh and Choudhary (1977).

Results And Discussion

Analysis of variance revealed significant differences among the genotypes for all the characters, indicating presence of wide spectrum of variability (Table 1).Wide range of variation was observed for most of the traits like days to 50% flowering, days to maturity, plant height (cm), primary branches per plant, secondary branches per plant, main shoot length (cm), siliqua on MSL, siliqua per plant, siliqua length (cm), seeds per siliqua, seed yield per plant (g), 1000- seed weight (g), oil content(%) and fiber content indicating considerable scope for improvement through conventional breeding approach. Meena *et al.* (2008) and Shekhawat *et al.* (2014) reported wide range of such type of variability, which indicate that the extent of variability may indeed be real.Estimates of PCV and GCV were observed higher for various traits including seed yield per plant, secondary branches per plant, 1000 seed weight and siliquae per plant. Similar findings were reported for different traits in Indian mustard by Patel *et al.* (2006), Singh *et al*. (2014), Shekhawat *et al.* (2014). The coefficient of variation doesn't offer the full scope of heritable variation. It can be determined with greater degree of accuracy when heritability in conjunction with genetic advance is studied. Hence, heritability and genetic advance are important parameters to study the scope of improvement in various characters through selection. High heritability estimates along with high genetic advance are more helpful in predicting the gain under selection than heritability estimates alone.

In the present study, high heritability coupled with high genetic advance was observed for for number of secondary branches, seed yield per plant and 1000 seed weight. High heritability coupled with medium genetic advance for fiber content and days to maturity. Medium heritability with medium genetic advance was number of siliquae per plant. Low heritability with low genetic advance was plant height. This indicated that improvement in these traits could be made by simple selection. Panse (1978) expressed that high heritability together with high genetic advance was an indicative of additive gene effects, and high heritability associated with low genetic advance was indication of dominance and epistatic effects. These results are in conformity with those obtained by Patel *et al.* (2006), Nasim *et al.* (2013) and Shekhawat *et al.* (2014) in Indian mustard. In contrast to present results, Mahla (2003) reported high heritability estimates for days to flowering and oil content, whereas, Larik and Rajput (2000) reported low genetic advance for plant height and days to maturity. The variation in the findings of different studies could be ascribed to differences in environment, and also due to different material used.

In the present study, the genotypic correlation coefficients were higher in magnitude than their respective phenotypic correlation coefficients for most of the traits indicating the depression of phenotypic expression by the environmental influence. Seed yield per plant showed positive and highly significant correlation with significant association with plant height, primary branches per plant, secondary branches per plant and number of siliqua per plant at both phenotypic and genotypic levels (Table 3). Such positive association of seed yield/ plant with primary branches/ plant, secondary branches/ plant, number of seeds/ siliqua was also observed by Yadava *et al.* (2011), Nasim *et al.* (2013), Khan and Amjad (2014) and Shweta (2014)Singh and Singh (2010), and Singh *et al.* (2003) for main shoot length, and Malik *et al.* (2000) for siliqua length. However seed yield was negatively and significantly correlated with fibre content.

The estimates of correlation coefficient, although, indicate inter- relationship of different traits, but it does not furnish information on cause and effect.Under such situation path analysis helps the breeder to identify the index of selection. Seed yield per plant was exerted positive direct effects by siliquae on main shoot, days to 50% flowering, seeds per siliqua, secondary branches per plant, seeds per siliquae, siliqua length and oil content. The above findings suggested the inter relationship between the seed yield per plant and primary and secondary branches per plant and siliquae per plant. Thus, direct selection for maximum siliquae on main shoot length, seeds per siliqua, secondary branches per plant, seeds per siliquae, siliqua length will result in improvement of seed yield per plant. Because, other component characters correlated response in component characters will automatically be obtained. Therefore, considering these traits as selection criteria will be advantageous in bringing improvement in Indian mustard. These results are in conformity with the findings Lodhi *et al.* (2014), Khan and Amjad (2014). Days to 50% flowering, although, showed positive direct effects on seed yield per plant, but had non significant correlation which may have negative effects via other traits. Since oil content was negatively correlated and had negative direct effect on seed yield/ plant it implies that consideration of this trait for increasing oil content is also valuable. Thus, the material studied is of diverse nature and information emanated would help in designing the selection methodology which can further be used in the breeding programme for improvement of seed yield.

Table 1. Analysis of variance of morphological characters of Indian Mustard

Source	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Main shoot length (cm)	Siliqua on MSL	Siliqua per plant	Siliqua length (cm)	Seeds per siliqua..	Seed yield per plant (g)	1000-seed weight (g)	Oil content (%)	Fiber content (%)
Rep.	2	2.47	8.60	309.83	0.47	0.02	33.29	82.77	475.60	0.61	4.04	5.51	0.13	2.02	0.04
Treatment	63	11.88**	189.3**	294.03*	0.95**	9.68**	90.58**	66.88**	2460.9**	0.29*	2.03*	51.73**	2.36**	5.23**	2.12**
Error	126	4.50	10.59	194.89	0.43	0.15	47.31	23.55	308.02	0.18	1.11	2.96	0.05	0.28	0.08

* and ** Significant at 5% and 1% level of significance, respectively.

Table 2. Genetic variability of morphological and quantitative characters of Indian Mustard

Characters	Mean	Range	Heritability (%)	GCV (%)	PCV (%)	Genetic Advance	GA % means
Days to 50% flowering	45.54	39.00 -48.33	35.38	3.45	5.79	1.92	4.22
Days to maturity	129.65	109.67 -141.33	84.90	5.95	6.46	14.65	11.30
Plant height (cm)	153.60	136.00- 178.47	14.50	3.74	9.83	4.51	2.94
Primary branches per plant	4.98	3.67-6.40	28.72	8.37	15.61	0.46	9.23
Secondary branches per plant	5.66	3.00-11.13	95.39	31.50	32.26	3.59	63.38
Main shoot length (cm)	52.86	37.87-7035	23.36	7.18	14.86	3.78	7.15
Siliqua on MSL	36.99	26.73-52.87	38.02	10.27	16.66	4.83	13.05
Siliqua per plant	153.07	100.20-244.73	69.97	17.50	20.92	46.16	30.16
Siliqua length (cm)	4.79	3.73-5.46	18.35	4.14	9.67	0.18	3.66
Seeds per siliqua	12.71	10.33-14.73	21.80	4.37	9.35	0.53	4.20
Seed yield per plant (g)	12.35	5.33-29.00	84.58	32.64	35.49	7.64	61.84
1000- seed weight (g)	4.88	3.15-7.46	93.60	17.98	18.59	1.75	35.83
Oil content (%)	41.41	38.46-43.50	85.51	3.10	3.35	2.45	5.91
Fiber	9.23	7.12-11.15	88.83	8.91	9.46	1.60	17.30

Table 3. Genotypic and phenotypic correlation between different morphological and quantitative traits of Indian mustard

Characters		Days to maturity	Plant height (cm)	Pri. Br. /plant	Sec.br. / plant	Shoot length (cm)	Siliqua on MSL	Siliqua /plant	Siliqua length (cm)	Seeds /siliqua.	Seed yield / plant (g)	1000-seed wt. (g)	Oil content (%)	Fiber
Days 50% Flo.	G	0.406**	0.182*	-0.048	0.05	0.388**	0.081	-0.279**	-0.590**	-0.196**	-0.076	-0.203**	0.313**	0.274**
	P	0.254**	-0.015	0.028	0.023	0.092	0.003	-0.143*	-0.087	-0.024	-0.069	-0.104	0.131	0.150*
Days to maturity	G		-0.154*	-0.175*	0.125	0.452**	0.013	-0.047	0.224**	0.034	0.081	0.092	-0.102	-0.196**
	P		-0.005	-0.094	0.106	0.121	-0.033	-0.036	0.109	0.007	0.068	0.083	-0.088	-0.166*
Plant height (cm)	G			0.598**	0.783**	0.313**	0.892**	0.660**	0.095	-0.610**	0.342**	-0.232**	-0.195**	-0.421**
	P			0.186**	0.297**	0.206**	0.398**	0.292**	-0.034	-0.126	0.208**	-0.062	-0.037	-0.153*
Pri. Br. /plant	G				0.565**	0.002	0.340**	0.464**	0.261**	0.044	0.325**	-0.008	0.009	0.002
	P				0.311**	0.045	0.210**	0.203**	-0.013	0.096	0.168*	-0.026	-0.072	0.02
Sec.br. / plant	G					0.677**	0.847**	0.651**	0.263**	-0.360**	0.246**	-0.011	-0.238**	-0.226**
	P					0.342**	0.527**	0.538**	0.12	-0.156*	0.224**	-0.011	-0.216**	-0.208**
Shoot length (cm)	G						0.698**	0.346**	0.235**	-0.263**	0.077	-0.064	-0.339**	-0.032
	P						0.550**	0.199**	0.094	-0.072	0.093	-0.031	-0.134	-0.045
Siliqua on MSL	G							0.644**	0.191**	-0.655**	0.044	0.032	-0.362**	-0.205**
	P							0.423**	0.122	-0.073	0.065	-0.029	-0.235**	-0.173*
Siliqua /plant	G								0.424**	-0.313**	0.229**	-0.055	-0.359**	-0.263**
	P								0.171*	-0.086	0.221**	-0.044	-0.288**	-0.204**
Siliqua length (cm)	G									-0.501**	-0.156*	0.448**	-0.533**	-0.450**
	P									0.114	-0.061	0.192**	-0.165*	-0.180*
Seeds /siliqua.	G										0.139	-0.105	-0.028	0.022
	P										0.065	-0.063	-0.022	-0.006
Seed yield / plant (g)	G											-0.072	0.073	-0.292**
	P											-0.069	0.056	-0.249**
1000- seed wt. (g)	G												-0.270**	-0.149*
	P												-0.243**	-0.132
Oil content (%)	G													0.170*
	P													0.148*

G=Genotypic, P=Phenotypic, *&** Significant at 5% and 1%

Table 4. Genotypic and phenotypic path between different morphological and quantitative traits of Indian mustard

Characters		Days 50% Flo.	Days to maturity	Plant height (cm)	Pri. Br. /plant	Sec.br. / plant	Shoot length (cm)	Siliqua on MSL	Siliqua /plant	Siliqua length (cm)	Seeds /siliqua.	1000-seed wt. (g)	Oil content (%)	Fiber	R with Seed yield / plant (g)
Days 50% Flo.	G	**0.442**	-0.024	-0.088	-0.003	0.020	-0.204	0.041	-0.067	-0.079	-0.079	0.033	0.038	-0.105	-0.076
	P	**-0.071**	0.015	-0.002	0.003	0.003	0.011	-0.001	-0.023	0.011	-0.003	0.003	0.018	-0.034	-0.069
Days to maturity	G	0.179	**-0.060**	0.075	-0.012	0.049	-0.237	0.007	-0.011	0.030	0.014	-0.015	-0.012	0.075	0.081
	P	-0.018	**0.057**	-0.001	-0.011	0.015	0.014	0.007	-0.006	-0.013	0.001	-0.002	-0.012	0.037	0.068
Plant height (cm)	G	0.080	0.009	**-0.485**	0.040	0.307	-0.164	0.451	0.159	0.013	-0.245	0.038	-0.024	0.161	0.342**
	P	0.001	0.000	**0.132**	0.021	0.041	0.024	-0.079	0.047	0.004	-0.014	0.002	-0.005	0.034	0.208**
Pri. Br. /plant	G	-0.021	0.010	-0.291	**0.068**	0.222	-0.001	0.172	0.112	0.035	0.018	0.001	0.001	-0.001	0.325**
	P	-0.002	-0.005	0.024	**0.114**	0.043	0.005	-0.042	0.033	0.002	0.011	0.001	-0.010	-0.004	0.168*
Sec.br. / plant	G	0.022	-0.007	-0.380	0.038	**0.393**	-0.355	0.428	0.157	0.035	-0.144	0.002	-0.029	0.087	0.246**
	P	-0.002	0.006	0.039	0.035	**0.138**	0.040	-0.104	0.086	-0.015	-0.017	0.000	-0.030	0.047	0.224**
Shoot length (cm)	G	0.171	-0.027	-0.152	0.000	0.266	**-0.525**	0.353	0.084	0.032	-0.105	0.010	-0.042	0.012	0.077
	P	-0.007	0.007	0.027	0.005	0.047	**0.117**	-0.109	0.032	-0.012	-0.008	0.001	-0.018	0.010	0.093
Siliqua on MSL	G	0.036	-0.001	-0.433	0.023	0.332	-0.366	**0.506**	0.155	0.026	-0.263	-0.005	-0.044	0.079	0.044
	P	0.000	-0.002	0.052	0.024	0.073	0.064	**-0.198**	0.068	-0.015	-0.008	0.001	-0.032	0.039	0.065
Siliqua /plant	G	-0.123	0.003	-0.321	0.031	0.256	-0.181	0.325	**0.242**	0.057	-0.125	0.009	-0.044	0.101	0.229**
	P	0.010	-0.002	0.038	0.023	0.074	0.023	-0.084	**0.160**	-0.021	-0.010	0.001	-0.039	0.046	0.221**
Siliqua length (cm)	G	-0.261	-0.013	-0.046	0.018	0.103	-0.123	0.096	0.102	**0.135**	-0.201	-0.073	-0.065	0.173	-0.156*
	P	0.006	0.006	-0.004	-0.001	0.017	0.011	-0.024	0.027	**-0.124**	0.013	-0.006	-0.023	0.040	-0.061
Seeds /siliqua.	G	-0.087	-0.002	0.296	0.003	-0.141	0.138	-0.331	-0.076	-0.067	**0.401**	0.017	-0.003	-0.008	0.139
	P	0.002	0.000	-0.017	0.011	-0.021	-0.008	0.014	-0.014	-0.014	**0.111**	0.002	-0.003	0.001	0.065
Seed yield / plant (g)	G	-0.090	-0.006	0.113	-0.001	-0.005	0.033	0.016	-0.013	0.060	-0.042	**-0.163**	-0.033	0.057	-0.072
	P	0.007	0.005	-0.008	-0.003	-0.002	-0.004	0.006	-0.007	-0.024	-0.007	**-0.029**	-0.033	0.030	-0.069
1000-seed wt. (g)	G	0.138	0.006	0.095	0.001	-0.093	0.178	-0.183	-0.087	-0.072	-0.011	0.044	**0.122**	-0.065	0.073
	P	-0.009	-0.005	-0.005	-0.008	-0.030	-0.016	0.047	-0.046	0.020	-0.002	0.007	**0.137**	-0.033	0.056
Oil content (%)	G	0.121	0.012	0.204	0.000	-0.089	0.017	-0.104	-0.064	-0.061	0.009	0.024	0.021	**-0.384**	-0.292**
	P	-0.011	-0.010	-0.020	0.002	-0.029	-0.005	0.034	-0.033	0.022	-0.001	0.004	0.020	**-0.224**	-0.249**

G=Genotypic, P=Phenotypic, *&** Significant at 5% and 1%

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